**Session Proposal**

# **Session Title**

# Next-Generation Pyrogenic-C Systems: From Molecular Mechanisms to Planetary-Scale Impacts

# **Session Organizers**

* Jianming Xu (Zhejiang University, China | Email: [jmxu@zju.edu.cn](https://mailto:xujm@zju.edu.cn/" \t "_blank))
* Johannes Lehmann (Cornell University, USA | Email: [jl2222@cornell.edu](https://mailto:jl2222@cornell.edu/" \t "_blank))
* Yu Luo (Zhejiang University, China | Email: [luoyu@zju.edu.cn](mailto:luoyu@zju.edu.cn))

# **Session Description**

This session explores the transformative potential of pyrogenic carbon (pyrogenic-C), engineered or derived from wildfires, as a microbial and biogeochemical cycle regulator. It examines its capacity to shape interactions among bacteria, fungi, and viruses, driving various processes such as carbon sequestration, nutrient cycling, and pollutant detoxification. The session also investigates the multifaceted role of pyrogenic-C in shaping soil biogeochemical processes through microbial and physicochemical mechanisms. For instance, pyrogenic-C modulates fungal-bacterial competition for labile carbon and nutrient acquisition, while its porous architecture and redox-active surfaces enhance soil aggregate stability and organo-mineral complexation, promoting long-term carbon sequestration. Simultaneously, pyrogenic-C regulates greenhouse gas emissions, such as suppressing CH₄ emissions through methanotrophic enrichment and reducing N₂O emissions via denitrification, while also improving crop resilience by mitigating soil moisture extremes and enhancing root-microbe symbiosis. Based on these mechanisms, engineering strategies, such as the design of microbial communities embedded in pyrogenic-C matrices, offer tailored solutions for extreme environmental conditions, including heavy metals, saline-alkali soils, and post-fire soils. Additionally, advanced methodologies like stable isotope probing, microfluidic soil chips, and metatranscriptomics are employed to identify keystone microbial taxa and pathways where pyrogenic-C functions as a dual player in soil processes, such as reducing CH₄/N₂O emissions and enhancing carbon sequestration in soil.

We invite interdisciplinary contributions that bridge molecular mechanisms, such as phage-host interactions and enzyme expression tracking, to understand ecosystem outcomes, thereby fostering climate-smart agriculture aligned with SDGs 2 and 13. Young researchers and global experts are encouraged to share innovative omics-guided modeling, field-scale validation, and planetary-scale impact assessments. This session aims to catalyze collaborative frameworks for sustainable soil management, unlocking the potential of pyrogenic-C as a key player in the Soil-Climate-Health nexus.

# **Format**

* Keynote Lectures (2×20 mins)  
  Global leaders bridging molecular and planetary scales of pyrogenic-C research.
* Rapid-Fire Oral Presentations (8×10 mins)  
  Peer-selected studies on breakthrough methodologies or cross-system synergies.
* Poster Pitches & Augmented Reality Demo (20 mins)  
  AI-powered matchmaking between poster presenters and attendees, with live holographic visualization of pyrogenic-C microbe interactions.
* Collaboration Incubator (15 mins)  
  Guided networking to form multinational teams addressing session-identified knowledge gaps.

# **Proposed Speakers**

Leading International Experts in Pyrogenic-C Research

1. Johannes Lehmann  
   Cornell University, USA  
   Global authority on Pyrogenic-C systems, pioneered Pyrogenic-C accounting methods and developed the "Pyrogenic-C geochemical threshold" theory adopted in IPCC climate models.
2. Jianming Xu  
   Zhejiang University, China  
   Pioneer in soil-Pyrogenic-C interfacial processes, revealed redox-coupled mechanisms regulating organic carbon dynamics, and developed nanoscale nutrient tracking technologies.
3. Matthias Rillig  
   Free University of Berlin, Germany  
   Global leader in fungal-Pyrogenic-C interactions, discovered hyphal transport mechanisms of Pyrogenic-C nanoparticles and proposed the "Pyrogenic-C niche construction" theory.
4. Claudia Kammann  
   Hochschule Geisenheim University, Germany  
   Pyrogenic-C-plant interaction expert, established metabolomic databases for root exudates under Pyrogenic-C amendment and decoded nitrogen-use efficiency regulation pathways.
5. Stephen Joseph  
   University of New South Wales, Australia  
   Founding figure in Pyrogenic-C engineering, developed 20+ targeted pyrolysis protocols for agricultural waste and led ISO Pyrogenic-C standardization.
6. Qimei Lin  
   Guangdong Academy of Agricultural Sciences, China  
   Innovator in Pyrogenic-C mediated soil microbial reactivation, demonstrated Pyrogenic-C’s role in restoring degraded agroecosystems through microbiome reprogramming.
7. Bruce Hungate  
   Northern Arizona University, USA  
   Authority on Pyrogenic-C carbon stability, quantified millennial-scale degradation kinetics across climate zones using 13C isotopic tracing.
8. Wenfeng Cheng  
   Chinese Academy of Engineering, China  
   Visionary in Pyrogenic-C-based circular agriculture, engineered multifunctional Pyrogenic-C systems integrating soil remediation with crop productivity enhancement.
9. Caroline Masiello  
   Rice University, USA  
   Pioneer in Pyrogenic-C structure-function relationships, established fractal theory for nano-porosity and revealed ecological gradients in surface chemistry.
10. Fangbai Li  
    Guangdong Academy of Sciences, China  
    Leader in red soil remediation, developed Fe/Mn oxide-modified Pyrogenic-C for simultaneous heavy metal immobilization and agricultural production.
11. Bruno Glaser

University of Bayreuth, Germany

Terra Preta soils, biochar stability in ecosystems, and interactions between biochar and soil microorganisms.

1. Saran Sohi

University of Edinburgh, UK

Biochar carbon storage potential, soil organic matter dynamics, and policy frameworks for carbon removal.

1. Lukas Van Zwieten

NSW Department of Primary Industries, Australia

Biochar impacts on soil health, crop productivity, and environmental benefits in temperate regions.

1. Xiaoyuan Yan

Chinese Academy of Sciences, China

Biochar for heavy metal immobilization, soil remediation, and sustainable rice cultivation.

1. Yakov Kuzyakov

University of Göttingen, Germany

Soil carbon dynamics, biochar stability, rhizosphere interactions, and carbon sequestration mechanisms.

1. Jörg Rinklebe

University of Wuppertal, Germany

Biochar applications in contaminated soil remediation (especially wetlands and waterlogged soils), and its role in regulating the transport and transformation of heavy metals and organic pollutants.

1. Yong Sik Ok

Korea University, South Korea

Biochar applications in soil remediation, carbon sequestration, environmental sustainability, and global biochar initiatives

1. Nanthi Bolan

University of Western Australia, Australia

Multi-functional applications of biochar in soil enhancement, nutrient retention, and remediation of polluted environments.